

# **Paleoliquefaction Study of the Willamette River Valley, Portland to Corvallis, Oregon**

02HQGR0021

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Element II (Research on Earthquake Occurrence and Effects)

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## **Investigations Undertaken**

Prior work in the Columbia and Willamette river systems in Oregon identified paleoliquefaction structures. Atwater (1994) and Obermeier and Dickinson (1997) surveyed the Columbia River, and Maden, (written communication, 1999) describes paleoliquefaction structures in the Portland area at seven sites found in excavations.. Obermeier and Dickenson found paleoliquefaction structures between 35 and 90 km from the mouth of the Columbia. The structures they found are all related to the great 1700 A.D. earthquake documented on the Washington and Oregon coast by Atwater (1987, 1995). Many deposits exposed along the Columbia are historical, based on navigation charts that show the river banks changing by tens of meters in decades, either due to erosion or deposition (Maden, written communication, 1999). Prior work in the Willamette River system is of reconnaissance nature only and most of the data remains unpublished (Thurber and Obermeier, 1996, unpublished manuscript).

Goals of this project are to test the feasibility of (1) defining the age and size distribution of liquefaction features in the Willamette River valley, (2) estimate the age, magnitude, and recurrence intervals of prehistoric earthquakes that produced liquefaction, and (3) possibly identify likely earthquake source(s) from these data. Towards this end, I conducted canoe reconnaissance with Martitia Tuttle for liquefaction features along portions of the Calapooia, Luckiamute, and Willamette rivers. I conducted further reconnaissance with a volunteer assistant along South Fork of Santiam, and additional parts of the Willamette rivers (Fig. 1). I also conducted auto reconnaissance along the lower 40 km of the North Fork Santiam River and along the South Yamhill River from near Amity to its mouth.

The canoe reconnaissance was conducted using standard procedures developed largely in the central United States by Obermeier, Tuttle, Schweig, and Sims. Cut bank exposures are examined for evidence of paleoliquefaction features, primarily sand dike intrusions. Stratigraphic context is established and samples of organic material for radiocarbon analysis collected whenever available.

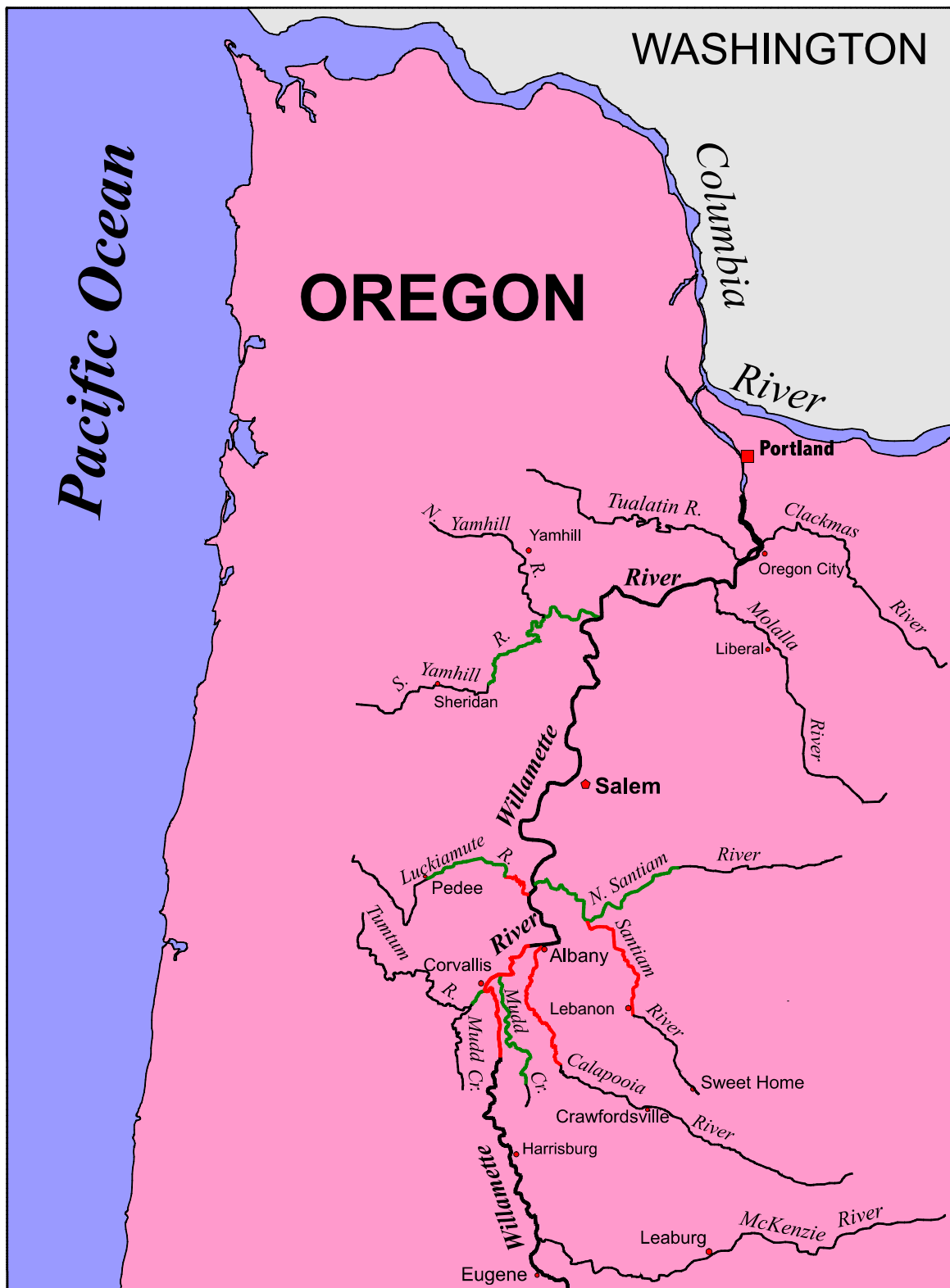


Figure 1  
Will

amette Valley Rivers and reconnaissance completed in 2002. Detailed reconnaissance by raft and canoe in red, road reconnaissance in green.

## Results

We completed detailed reconnaissance by canoe and raft totaling 135 km on the, Calapooia, Luckiamute, Willamette, and South Fork Santiam rivers. We also conducted auto reconnaissance along about 40 km of the North Fork Santiam River, and the South Yamhill River from near Amity to it's mouth.

The surveys were conducted when the water level was low and cutbanks best exposed. The location of relevant features were measured with a global positioning system and marked on topographic base maps. Liquefaction features will be described in terms of their size (width of dikes, and lateral extent and thickness of sand blows and sills), orientation, sedimentary structures, cross-cutting relations, soil development, and stratigraphic context.

**Calapooia River:** We surveyed the lower 32 km of the Calapooia River from the confluence of Butte Creek to the mouth at Albany. The Calapooia above the confluence with Butte Creek becomes too shallow for canoe, and its banks are low and heavily vegetated. We found exposures containing sand dikes along the Calapooia (Table 1). We also discovered Native American presence occupation sites at CR-2 and 11, which contained ancient firepits with abundant charcoal. In general the stratigraphic section is well exposed along the Calapooia. We measured several sections that have datable material that will allow us to place the sand dikes in context.

Table 1.

| Location | No. of Dikes | Events | Radiocarbon Samples |
|----------|--------------|--------|---------------------|
| CR-3     | 1            | 1      | none                |
| CR-5     | 1            | 1      | none                |
| CR-8     | 4            | 1?     | none                |
| CR-10    | 2            | 2      | min age             |
| CR-13    | 1            | 1      | max age             |

Radiocarbon samples have been submitted to Beta Analytic for analysis and dating of sand dikes and stratigraphic units that they cut.

**Luckiamute River:** We completed a detailed survey of the lower 25 km of the Luckiamute river from about 2.5 km above Helmick State Park to its mouth by canoe. We also conducted a road survey above Helmick State Park to the town of Pedee. Above Helmick State Park the banks of the Luckiamute River are relatively low and heavily vegetated and outcrops of bedrock occur in the upper 5-6 km.

Sand dikes were reported by Thurber and Obermeier (1996) In our detailed survey area we found no sand dikes. Outcrops are generally good but there are numerous exposures of bedrock that make the occurrence of sand dikes unlikely.

**Willamette River:** We completed a detailed survey of the section of the Willamette River between river mile 151 and 122. In the upper part of this stretch exposures are excellent and of three types. The most abundant type of exposure is low banks of well exposed cobble gravel overlain by soil. The second most common type of exposure is well-exposed high banks of Missoula Flood deposits, and older Pleistocene deposits (O'Connor and others, 2001). The third type of sediment most often seen below Corvallis is various types of bedrock overlain by Missoula flood deposits and younger overbank deposits. From a few kilometers above Corvallis and downstream rip-rapping of cutbanks to control bank erosion is common. This obscures most of the likely areas of natural exposure. We found no sand dikes in the exposures along the Willamette River.

**South Fork Santiam River:** We completed detailed canoe reconnaissance of 30 km along the South Fork Santiam River from Lebanon, OR to the confluence with the North Fork Santiam River. Exposure are primarily limited to low banks containing cobble to boulder gravel overlain by thin silt deposits. Above Lebanon bedrock outcrops are common. Both of these factors severely limit the possibility of sand dikes being formed or exposed.

**North Fork Santiam River:** I conducted an auto reconnaissance of the North Fork Santiam River. From the several bridge crossings and easily reachable banks we characterize the North Fork Santiam River similar to the South Fork Santiam.

**South Yamhill River:** We conducted an auto reconnaissance of the South Yamhill River from just west of Amity to near the mouth and noted a number of promising outcrops. Time did not permit exploring these further.

### **References Cited**

- Thurber, B.W.C and Obermeier, S.F., 1996, Paleoliquefaction evidence for two late-Quaternary earthquakes, southern Willamette Valley, Oregon: Geological Society of America, Abstracts with Program, v. 28, no. 5, p. 117.
- O'Connor, J.E., Sarna-Wojcicki, A., Wozniak, K.C., Polette, D.J., and Fleck, R.J., 2001, Origin, extent, and thickness of Quaternary Geologic Units in the Willamette Valley, Oregon, U.S. Geological Survey Professional Paper 1620, 52 p.

### **Non-technical Summary**

We completed detailed reconnaissance by canoe and raft totaling 135 km on the, Calapooia, Luckiamute, Willamette, and South Fork Santiam rivers. We also conducted auto reconnaissance along about 40 km of the North Fork Santiam River, and the South Yamhill River from near Amity to its mouth. The surveys were conducted when the water level was low and cutbanks best exposed. The location of relevant features were measured with a global positioning system and marked on topographic base maps. Liquefaction features will be described in terms of their size (width of dikes, and lateral extent and thickness of sand blows and sills), orientation, sedimentary structures, cross-cutting relations, soil development, and stratigraphic context. Paleoliquefaction features were in the cutbanks of the Calapooia River. The Luckiamute, Willamette, and South Fork Santiam River did not yield exposures of paleoliquefaction features.

**Reports Published**

None

No seismic, geodetic, or processed data have been generated by this project.